IRRIGATION OF CORN IN THE EASTERN UNITED STATES

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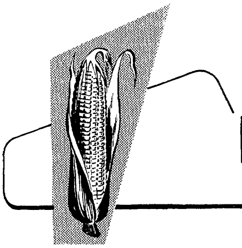

IRRIGATION OF CORN

IN THE EASTERN UNITED STATES

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Irrigation of crops in the eastern United States is often needed, although the area has a humid climate. However, in many sections of the area, water for irrigation is scarce and the farmer must consider how he can use the supply most advantageously.

Even where the average total annual rainfall exceeds 50 inches, frequent drought periods of 2 weeks or more occur during crop growing seasons (*5, 8, 18, 28, 29, 30*).[1] Much of the rainfall during the summer comes in storms of short duration and high intensity (*31*). On the fine-textured soils with a low rate of water intake, some rain that falls is lost as runoff; on coarse-textured soils, some rainfall is lost by rapid drainage to depths below the root zone. In addition to this, considerable quantities of rainfall moisture evaporate from the soil surface regardless of soil texture.

Growing competition with industrial and domestic users can be expected to reduce available sources of water for irrigation (*20, 25*). This competition for water indicates that efficient management of agricultural and industrial water usage is essential if the supply is to satisfy the needs. Whether water for irrigation comes from streams, reservoirs, wells, or farm ponds, it should be used on crops that will give highest returns per acre.

The quantity of water needed to produce a corn crop will depend on the climate at different locations. In some seasons and locations when there are long periods of cloudless skies and the temperature is high during dry windy days, water lost from an acre of growing corn will be more than when the sky is cloudy and the air is moist and relatively cool. In Missouri corn irrigation tests, total water loss by evaporation from soil and transpiration from plants (evapotranspiration) in 1954 and 1955 was estimated at 25 inches of water per acre when the soil was kept moist throughout the growing season. Data supplied by Van Bavel and Lillard's approximate values (*29*) indicate about 17 inches of water would be lost from an acre of corn during a 120-day growing season in the mountains of Virginia.

The water used by a crop of corn must come from rainfall stored in the soil before planting and that supplied by rainfall and irrigation or by irrigation while it is growing. In the semiarid regions of the United States, precipitation is generally insufficient to replenish storage in the root zone, and irrigation before planting is sometimes practiced. However, in the humid East, the soil storage reservoir is usually filled to near "field capacity" at planting time, and preseason irrigation is not necessary. Field capacity is the moisture retained in

[1] Italic numbers in parentheses refer to Literature Cited, p. 13.

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a soil with normal drainage about 2 days after the field has been thoroughly wetted by rain or by irrigation.

In order to make full use of the available stored moisture, roots must grow into and ramify the soil mass. The available moisture storage capacity of a soil is usually the maximum moisture that can be released to plant roots from the field capacity point to the permanent wilting point. The permanent wilting point is the amount of soil moisture at which most crop plants wilt when actively growing roots are well distributed in the soil mass.

The total quantity of water that is available for use by the growing crop from soil storage depends on the storage capacity of the soil and on the root distribution of the plants within the soil. A sandy soil may store about 0.7 inch of available water per foot of soil depth, while a silt loam will retain about 2.2 inches (*15*). Compact layers in some soils (*13*) may reduce water intake from winter rains and limit preseason storage and so add to the drought hazard in dry summers. A compact layer may also limit root growth into the subsoil and reduce the supply of storage water that is available to the crop. Corn roots are usually distributed so that less than one-fourth of the total withdrawal is from depths below 3 feet. During periods of extreme drought and with no irrigation, withdrawal of moisture below 3 feet is accompanied by slower growth and loss in yields. Even from soils with best storage of water, no more than 10 to 12 inches of stored water can be drawn by a corn crop unless replenished by rain or irrigation.

DOES IRRIGATION OF CORN PAY?

Unirrigated corn crops were near failures in many parts of the eastern United States for 4 of the 10 years 1946–56, and yields were sharply reduced in other years (fig. 1). On the other hand, rainfall has been ample in most of the East in some years and irrigation has had little or no effect on corn production. Supplemental irrigation of corn will vary from occasional use to save a crop or to tide over short drought periods (*4, 8, 9, 11, 12, 13, 16, 17, 18, 19, 21, 22, 23, 32*) to use of water on corn nearly every season when grown on soils of low storage capacity (*1, 2, 3*).

The answer to the question, "Does irrigation of corn pay?" will depend on the market value of the crop, the cost of production with and without irrigations, and upon yields. Also, if the supply of water is limited, as it often is in dry years, the grower must consider on what crops the short supply can best be used. Corn as a cash crop would probably have a high priority over some other crops. However, corn may have to give way to more advantageous use of water on such higher value crops as tobacco and vegetables.

Field Corn for Grain

Response of field corn to irrigation in the humid East depends upon soil and weather conditions during the growing season and other management practices in addition to irrigation. In growing seasons of low or poorly distributed rainfall, yield increases are usually greatest with irrigation during entire growing season, adequate fertilization, and fairly thick stands of 15 to 18 thousand stalks per acre (*6, 23*). However, the best returns per inch of water supplied are usually with

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Figure 1.—Appearance of irrigated corn (*A*) and unirrigated corn (*B*) in a South Carolina experimental plot, after a very dry growing season when rainfall for July and August was 2.30 inches.

conservative use of water during critical dry periods, particularly during the tasseling to early dent stage [2] of growth (*11, 12, 13, 16, 32*). Published information from some Eastern States (*1, 2, 3, 4, 17, 23, 32*) show more consistent increases in corn production with irrigation in areas of lower summer rainfall and on soils of low available moisture storage capacity.

Corn uses about 50 percent of the total available moisture in Piedmont soils of South Carolina in 8 to 10 days, and in the Coastal Plain sandy soils in 4 to 5 days (*17*). In most years increases in yield more than pay for irrigation on a soil like Bolivar silt loam in the Ozarks of Arkansas (*1, 2, 3*), but unless long summer droughts occur on a soil of high available moisture storage capacity like Sharon silt loam or Nicollet loam (*23*), supplemental water applied to corn will not pay. On upland and lowland sites in Alabama and Georgia (*9, 16*), economic returns for corn irrigation apparently can be expected only in years of severe moisture stress at the critical 3-week period just before, during, and after silking.

Supplemental water has been applied to corn during 8 of the last 9 years on Mexico silt loam at McCredie, Mo., in the period 1948–56. The June-through-August average rainfall was 11.04 inches, or about 1 inch below normal for a 60-year period. The average runoff for the 3-month summer period during the 9 years was only 0.91 inch. An average of about two irrigations, or 4.55 inches of water, was applied with an average increase of 77.4 bushels per acre, or a 17.0-bushel increase for each inch of water applied. At an estimated cost of $3.00 per inch of water used, each bushel increase would cost about $0.18. On Mexico silt loam most of the moisture withdrawal by corn roots is restricted by the claypan to the upper 2 feet of soil. The available moisture storage capacity of the surface silt loam is high (about 4 inches in the upper 2 feet). During hot summer days water use by corn in Missouri often exceeds 0.25 inch per day. A summer drought of 2 to 3 weeks will result in yield reduction, and a 30-day drought without irrigation in midsummer will result in a corn crop failure on this soil. Wherever a water supply can be made available to Mexico silt loam and used with adequate fertility and other good management practices, irrigation of corn at 1957 prices should pay good returns. Information on the probable length and duration of summer droughts to be expected in Missouri and elsewhere in the East will be useful in predicting under what price and cost levels corn irrigation will pay. Such information is being made available in some States (*28, 29, 30*).

Sweet Corn

Even though the production period for sweet corn is somewhat shorter than for field corn, it is often grown during spring or summer months when damaging droughts occur (*4, 18, 19*). Sweet corn is usually a high-value crop, so that even a moderate increase in costs for irrigation may mean a big increase in per-acre returns. In 2 dry years (1951, 1952) an average increase of 614 dozen ears per acre resulted from the supplementary application of about 8 inches of water at the Mississippi Truck Crops Branch Station (*4*). At $0.25 per dozen this would

[2] The critical period of maturity of corn is variously referred to as the "tasseling (or silking) to early dent (or milk) stage." The "milk stage" is a few days earlier and less definite than "early dent" and probably does not include the full critical maturing period. For consistency herein, the period is called "tasseling to early dent stage."

mean an average net return of \$153.50 per acre for these dry years. In the first 6 months of 1953 at this station, the total rainfall was over 45 inches (*18*). However, from May 19 there was no rain for 31 days. During this period about 4 inches of water applied in two irrigations on sweet corn increased the yield by almost 800 dozen ears per acre. Such dry periods of 2 weeks or more occur in Mississippi and elsewhere throughout the humid East. In 30 years of the 41-year period prior to 1955, droughts of 14 days or more with less than 0.24-inch rainfall have occurred at the Mississippi Truck Crops Branch Station during May and July, and in 26 years of this period during June.

Yields of sweet corn at the New York State Experiment Station (Geneva) in dry years have been increased by more than 1 ton per acre by irrigation (*19*). In other years, like 1956 when summer rainfall was adequate, no benefit resulted from supplemental irrigation. The tests at this location show that irrigation in dry years increased plant growth to silking time and that maintenance of adequate moisture thereafter until maturity increased ear size.

MANAGEMENT PRACTICES CHANGE WITH IRRIGATION

Varieties should be selected that are adapted to specific locations (*14*). Some corn varieties that grow well in the coastal areas are poor producers in the Piedmont and mountains. Other varieties are adapted to bottom lands and growth of these varieties may be retarded on uplands, owing to soil moisture stress. Generally, irrigation has little or no effect on lodging (*13*). Irrigated corn usually has better rooting to withstand wind, but lodging will increase if winds occur while the soil is wet. Ample soil moisture, either from rain or from irrigation, usually causes earlier maturity for most varieties (*23*).

Although yields generally increase with rainfall, high summer temperatures, particularly in the Middle West, seem to affect corn yields adversely (*2*, *23*). The number of hot days in Iowa in August 1954 and 1955 appeared to affect yield more closely than did the amount of rainfall. In South Carolina high temperatures (93° to 99° F.) over extended drought periods during 1957 caused "baking" of tassels, even where crops were irrigated. Poor pollination resulted. Cooler weather usually accompanies periods of rainfall, but air temperatures are not greatly influenced by irrigation. On the other hand, with excessive cloudiness during rainy periods in some growing seasons, the reduction in sunlight may reduce growth.

Areas under clear summer skies (*23*) respond better to thicker stands with irrigation than areas of more prevalent cloudy weather.

Soil moisture, whether from rainfall or irrigation, is used most efficiently by corn growing on adequately fertilized soil (*24*). An application of 100 to 150 pounds of nitrogen per acre appears to satisfy the nitrogen requirements of irrigated corn. In addition to nitrogen, any needs for potassium and phosphorus shown by soil tests or direct field tests should be supplied, following the recommendations of the State agricultural experiment station. Lime should be applied as needed to maintain a pH of 6.0 to 6.5. The choice of dolomitic or calcic limestone will depend upon the relative need for calcium and magnesium in the soil. Here again, local recommendations should be followed.

Corn populations have been adjusted at several levels by changing row widths and spaces between plants in the row. When the number of plants are much greater than 15 to 18 thousand plants, tall spindly and weak plants develop that lodge easily (*6*, *23*). Ears on plants of populations exceeding 15 thousand are usually very small, and prolific varieties may set only one ear per stalk. In the humid East best yields are obtained with about 15 thousand plants per acre in rows about 40 inches apart.

WHEN TO IRRIGATE

Corn should be irrigated whenever necessary for continued healthy growth and to prevent reduction in yields as a result of soil moisture stress (fig. 2). The optimum soil moisture range for corn growth appears to be at low moisture stress (*10*), or from 100 percent of the available stored water in the soil down to about 50 percent as measured at the 8-inch depth. Research in Virginia[3] and South Carolina (*17*) indicates some growth reduction in early stages will not substantially reduce corn yields, although the available soil moisture may drop to near the 20-percent level. However, such low moisture is very critical for corn production from the time the plants begin to tassel until they reach the early dent stage (fig. 3). Corn irrigated only during this stage usually produces yields almost equal to those of corn irrigated throughout the growing season. Yield increases per inch of water applied are greater for irrigations during tasseling to early dent stage than by irrigations throughout the growing season (*13*, *16*, *32*).

[3] Unpublished data.

Judging From Appearance of Soil or Plants

Corn uses about 50 percent of the total available moisture in Piedmont soils in 8 to 10 days, and in Coastal Plain sandy soils in 4 to 5 days (*17*). On some deep silt loam soils (*23*) of higher storage capacity, ample moisture is available to corn for 2 weeks or longer.

A visual aid that may be used to estimate soil moisture conditions is "balling" the soil in the hand (*7*). About 50 percent or more of the

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Figure 2.—**Yields of irrigated (left) and unirrigated corn (right) from one-fiftieth acre.**

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Figure 3.—Field of irrigated and unirrigated corn in South Carolina when rainfall during growing season was 6.62 inches. Irrigated corn received 6.90 inches of water during tasseling to early dent stage. It yielded 69 bushels per acre while the unirrigated crop was a failure.

available moisture has been removed from a sandy loam soil when it will not ball under hand pressure; from a loam or silt loam when it will ball but is crumbly; and from a clay or clay loam when it is slightly pliable, but cracks appear. Corn usually wilts in the morning and recovers overnight when the available moisture is near the 50-percent level. However, exceptionally high temperatures and low humidity will cause corn to wilt temporarily when the soil moisture is relatively high.

Criteria for determining when to apply water can be a combination of these observations. The soil should be examined for balling and the corn leaves watched for morning wilt. The sample for the soil observation should be taken from about the 8-inch depth. Soil nearer the surface may be more nearly air-dry. Irrigation should not be delayed when the soil and the plants show evidence of moisture shortage. Delaying a needed irrigation as much as 2 or 3 days may be detrimental to plant growth.

Use of Soil Moisture Meters

Commercially available tensiometers and electrical resistance cells will also provide estimates of soil moisture content. Gypsum, fiber glass, and nylon electrical resistance cells have been used to some extent. If carefully calibrated in the specific soil, these units will give estimates of degree of moisture depletion at a given depth.

Use of Weather Records

The available moisture remaining in the soil may be determined by a "balance" system. This method is based on the assumption that most crops in healthy vegetative growth on soils adequately supplied with moisture will transpire about the same amount of water each day under the same weather conditions. If values for daily water lost by evaporation and transpiration and the amount of available water that can be stored in the root zone of the soil are known, the time to irrigate can be estimated to the day.

Estimates of the available storage capacities of different soil types are given in the Soil Conservation Service Irrigation Guides (*26*), where these are available. The guides are revised from time to time in order to present the most reliable current information. Where no guide is available, the approximate available moisture-holding capacity for different soil textures, as given below, may be used.

Soil texture:	*Available water (inches per foot)*
Sandy	0.7
Sandy loam	1.3
Loam	1.8
Silt loam	2.2
Clay loam	1.9
Clay	1.8

Values for daily evapotranspiration losses have been estimated by Van Bavel (*27*) and are shown in table 1. Use of the balance system to determine time to irrigate is shown by the example given in table 2. The starting balance is established after sufficient rainfall or irrigation fills the storage capacity of the soil to the 2-foot depth. In table 2, corn will be irrigated when 50 percent of the available water in the 2-foot depth has been used. The farm is located between latitude 30° and 34° N.

TABLE 1.—*Estimated values of daily evapotranspiration during certain months and for different latitudes under specified weather conditions*

Latitude [1] and month	Daily evapotranspiration during—		
	Dull, cloudy weather	Normal weather	Bright, hot weather
	Inch	*Inch*	*Inch*
Between 48° and 40° N.:			
April and September	0.06	0.09	0.13
May and August	.07	.12	.18
June and July	.12	.17	.22
Between 40° and 34° N.:			
April and September	.08	.11	.14
May and August	.11	.14	.19
June and July	.14	.17	.23
Between 34° and 30° N.:			
April and September	.09	.13	.16
May and August	.13	.16	.22
June and July	.14	.17	.23

[1] The values given in (*27*) have been expanded by Van Bavel to include the latitudes shown.

TABLE 2.—*Example showing how to use weather records to estimate time to irrigate corn in a sandy loam field located between latitude 30° and 34° N.*

[Crop to be irrigated when 50 percent of the available water in the 2-foot depth has been used]

Date	Evapotranspiration	Rainfall	Irrigation	Balance
	Inch	*Inches*	*Inches*	*Inches*
June 2		2.23		2.00
June 3	0.23			1.77
June 4	.23			1.54
June 5	.17			1.37
June 6	.23			1.14
June 7	.14	.13		1.13
June 8	.23			.90
June 9			1.50	2.00

On June 2 the rainfall of 2.23 inches was sufficient to fill the 2-foot soil storage capacity with 2.00 inches of water. Since the effective root-zone depth is 2 feet and 2.00 inches of water are required to fill the storage capacity of sandy loam to this depth, the established balance is 2.00 inches, which was entered in the balance column (table 2). Evapotranspiration values for June 3 through 8 were taken from table 1. Time to irrigate was when 50 percent of the available water in the 2-foot depth was used. On June 9, 1.50 inches of water was applied, and the balance was once more up to 2.00 inches. Excesses above a 2.00-inch balance are discarded, since they are considered lost by drainage into the subsoil or by runoff. Day by day, the record is kept in this manner. A new balance is obtained each day by adding rainfall and water applied by irrigation and subtracting the evapotranspiration values from the balance.

Growth of corn will continue after the base amount of moisture is gone, but not without some reduction in rate. Some corn roots will withdraw moisture from below the second, third, or even fourth foot of soil depth after the upper reserves are exhausted, but growth will be slower than if moisture is adequate. Decrease in growth will be accompanied by losses in yield, if prolonged moisture stress and wilting occurs during the tasseling to early dent stage (*32*).

IRRIGATION METHODS

Slope, intake rate, and other characteristics of the soil determine the method of irrigation to be used. Furrow methods are used on land with slopes of less than 0.5 percent or almost level. Sprinklers are used on deep sandy soils of high intake rate, on rolling land, on steep slopes, or where grading will remove too much fertile soil in cutting down ridges and knolls.

Sprinkler Method

The sprinkler system should be designed by a competent technician. The layout should be planned to fit all fields that are to be irrigated. Sprinklers should be selected that will apply water at the proper rate and that give proper coverage. Sprinkler irrigation of corn requires risers up to 10 to 12 feet in length that must be well supported.

The water source, its location with respect to the field, and the nature and size of the fields to be irrigated principally determine the layout of the system. Since power consumed by sprinkling water under pressure increases both with height and distance from source to the sprinklers, the fields to be irrigated should be as close as possible to the water supply.

The sizes of pipe should be chosen for both economy and good pressure distribution. Cost increases with pipe diameter. Main line and lateral line sizes should be selected with consideration for adequate distribution with greatest economy. Help in planning an irrigation system may be obtained from the Soil Conservation Service technician or the Extension Service engineer in the area concerned. The system should be large enough to get over the area to be irrigated as quickly and as often as necessary to prevent serious drought damage.

The number of hours needed to operate the system economically and conveniently should be considered. A smaller system can be used if it is operated 16 to 20 hours rather than the regular 8-hour day.

Distribution with sprinkling during windy periods is poor. Strong winds often occur at some locations during certain hours of the day; if possible, operation of sprinklers at such times should be avoided. Also, because of lower evaporation losses due to lower temperatures and higher humidity, irrigation at night may be profitable if the gain in efficiency is not offset by higher labor costs.

Moving sprinkler irrigation pipe in tall corn, without special mechanical aids, is difficult and expensive. Kummer (*16*) has tested the feasibility of leaving alleys in the corn for transporting and laying sprinkler lines. This means a sacrifice in land planted to crops to reduce labor costs.

Furrow Method

Furrow irrigation should not be used on slopes of more than 0.5 percent unless rows are laid on the contour (*7, 21*). Slopes of more than 2 percent should be considered too steep for furrow irrigation even when rows are graded to 0.5 percent on the contour. More nearly level land is easier to grade for furrow irrigation. Smoothing out irregularities is desirable, but land that requires extensive deep cuts to make it uniform should be irrigated by the sprinkling system. Land leveling is limited to soils that are deep enough that the needed cuts and fills do not permanently reduce productivity. Also, in humid areas, it is generally considered too costly to move more than 600 cubic yards of earth per acre.

The furrow method is best adapted to nearly level land (less than 0.5-percent slope), where little grading is needed, or to deep fertile soils where considerable soil can be cut from higher ridges and knolls without reducing productivity (*7*). Water for this method is distributed to the field by gravity from canals and ditches or by a system of pipelines.

The cost for equipment for pipelines is greater than for ditches for transportation of water to the field. Unless pipes are buried, they are difficult to cross or go around and bring inconvenience to the operation of farm machinery. Pipelines must be assembled where needed, and, unless extra pipe is bought, lines must be moved as progress is made across a field or when moved to new fields. During long periods of disuse the pipes should be disassembled and stored. Buried pipelines are expensive, but the initial cost may be more than offset by the durability and convenience of such system if it is properly planned and laid out. It is best to use gated pipe for distribution to the furrows (fig. 4). With a well-planned pipeline system on land well adapted to this method, good distribution of water can be achieved.

Ditches may be used to transport water to the field and distribute it to the furrows. Initial equipment costs are less, but extra land is needed. Ditches entail inconvenience in crossing with farm machinery and equipment. Also, with sandy or gravelly soils, water loss in transportation to the fields will be great unless the canals and ditches are lined with cement, plastic, or other materials. Seepage and transpiration losses increase as ditches become clogged with soil materials and weeds. Ditches must be maintained and kept free of debris. The best method of distribution from field ditches to furrows is by means of siphon hoses. By adjusting the size and number of siphons to each furrow the rate of flow and distribution can be controlled. Where it is desirable to irrigate in furrows graded on the

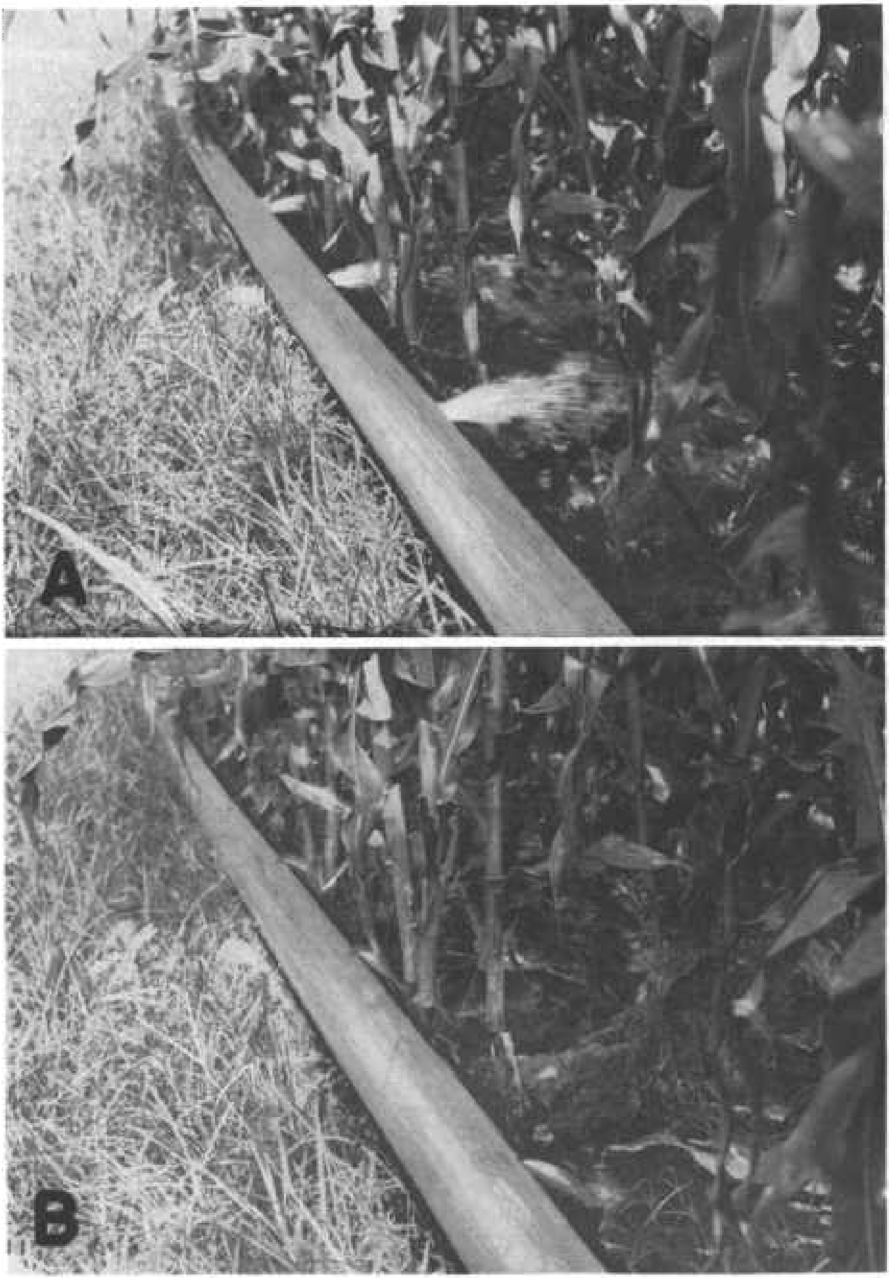

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Figure 4.—Use of gated pipe for furrow irrigation of corn: *A,* More rapid flow is used until water is nearly to the end of the furrow; *B,* then the rate is cut back to a slow rate until the desired amount is applied.

contour, the direction of slope should be chosen to give convenient access to the supply ditch.

Disposal of drainage from the lower end of the furrows should be considered. Also, ponding of water in the furrows from rainfall and irrigation often causes damage to the crop. A furrow grade of at least 0.05 percent with the direction of flow is needed to assure surface drainage (*21*).

AMOUNT AND RATE TO USE

Sprinkler Application

The application rate of water by sprinklers can be accurately controlled. The importance of applying water at a rate slow enough for the soil to absorb practically all as it falls cannot be overemphasized. When the water intake rate of soil is exceeded, the surface soil may be puddled, which reduces the intake rate and seals the soil surface; runoff occurs; aeration is impaired; and evaporation from the soil surface is increased.

Different soil types have varying capacities for storage of absorbed water. When a soil has been thoroughly wetted and excess water has drained, the soil water storage capacity is completely filled. Corn will exhaust water to depths greater than 2 feet, but irrigations will be made to recharge the soil capacity to the 2-foot depth, since most of the roots are in this zone.

The Soil Conservation Service Irrigation Guide (*26*) for each State is an excellent source of technical information for developing and operating the irrigation system. The South Carolina guide, for example, describes the soil profiles, gives application rates derived from experimental intake rates, and provides data of moisture to be replaced and amount to be applied, based on the efficiency of the sprinkler system. Data on root zone depths and peak use of moisture by most plants that may be irrigated are shown. Application rates can be increased to some extent under mulch tillage and on some very sandy soils on 1- to 2-percent slopes. However, extreme caution should be exercised in selecting other rates of application than those given.

Furrow Application

The application rate of water in furrow irrigation is determined by row spacing, row length, and amount of water turned into each furrow (*7, 21*). Soils with less than 0.5-percent slope, which soak up ½ to 1 inch of water per hour, are best suited to furrow application. The length of the furrow that can be irrigated from each field ditch or pipe setting will vary with different slopes and different soils. Usually water should be delivered to the lower end of the run in about one-fourth of the time necessary to deliver the full amount needed. When the water nears the lower end, the rate of flow should be reduced to avoid excessive waste. If gated pipe or siphons are used, the flow rate can be controlled easily. If openings to the furrows are made in field ditches and delivery laterals, adjustable weirs formed with stakes or other restrictive devices must be placed at the furrow intake end to control the amount of water. These need to be checked and adjusted frequently to avoid washouts and erosion damage.

GENERAL RECOMMENDATIONS

Plant a corn variety that is well adapted to the specific location and aim at about 15,000 plants per acre.

Fertilize with 100 to 150 pounds of nitrogen per acre. Apply phosphoric acid and potash according to soil tests or at the rate recommended by the State agricultural experiment station; usually about 100 pounds per acre of each. Maintain a pH value of 6.0 to 6.5.

Cultivate shallow to control weeds.

Irrigate throughout growing season if water supply is plentiful and time is not limited, or irrigate by the tasseling to early dent stage method if water and time are limited.

If there is no rain, corn will use about 50 percent of the total available water in silt loam bottom land in 12 to 15 days; in soils of the Piedmont in 8 to 10 days; and in sandy soil in the Coastal Plain in 4 to 5 days. To irrigate when about 50 percent of available soil water remains: (1) Examine corn for wilting about 10 a. m. and check soil at plow depth for "balling" test (p. 6); and (2) use weather data balance method of estimating when to irrigate, if possible.

Do not delay application of needed water.

Apply enough water to refill storage capacity of soil to about 2 feet deep.

LITERATURE CITED

(1) BROWN, D. A., and BENEDICT, R. H.
1953. INCREASING CORN YIELDS THROUGH SUPPLEMENTAL IRRIGATION. Ark. Farm Res. 2 (4): [3], illus.

(2) ——— and BENEDICT, R. H.
1954. INCREASING CROP YIELDS THROUGH IRRIGATION. Ark. Farm Res. 3 (4): [4], illus.

(3) ——— and BENEDICT, R. H.
1956. SUPPLEMENTAL IRRIGATION HELPS MAINTAIN CORN YIELDS. Ark. Farm Res. 5 (4): 4, illus.

(4) CAMPBELL, J. A.
1953. IRRIGATION FOR VEGETABLE CROPS. Miss. Agr. Expt. Sta. Cir. 182, 8 pp.

(5) DECKER, W. L.
1952. MONTHLY PRECIPITATION IN MISSOURI: CLIMATIC ATLAS OF MISSOURI NO. 1. Mo. Agr. Expt. Sta. Bul. 572, 80 pp., illus.

(6) DICKERSON, R. L., EDWARDS, F. E., JORDAN, H. V., and others.
1952. IRRIGATION EXPERIMENTS ON CROPS AND PASTURES. Miss. Farm Res. 15 (4): 4–5, illus.

(7) ——— GRISSOM, P., and RANEY, W. A.
1953. SELECTION AND USE OF IRRIGATION EQUIPMENT FOR MISSISSIPPI. Miss. Agr. Expt. Sta. Cir. 181, 14 pp., illus.

(8) EDWARDS, F. E., KIMBROUGH, E. A., DICKERSON, R., and others.
1951. EFFECTS OF IRRIGATION ON CORN AND PASTURE STUDIED. Miss. Farm Res. 14 (5): 1, 7, illus.

(9) ENNIS, L., JR.
1955. SUMMARY OF IRRIGATION EXPERIMENTS IN OTHER SOUTHEASTERN STATES. Ala. Agr. Expt. Sta. Water Resources and Sup. Irrig. Workshop Proc., pp. 19–22.

(10) GINGRICH, J. R., and RUSSELL, M. B.
1956. EFFECT OF SOIL MOISTURE TENSION AND OXYGEN CONCENTRATION ON THE GROWTH OF CORN ROOTS. Agron. Jour. 48: 517–520, illus.

(11) GRISSOM, P. H., RANEY, W. A., DICKERSON, R., and others.
1953. CROP RESPONSE TO IRRIGATION IN MISSISSIPPI. Miss. Agr. Expt. Sta. Cir. 180, 12 pp.

(12) ——— RANEY, W. A., and HOGG, P.
1955. CROP RESPONSE TO IRRIGATION IN MISSISSIPPI DELTA. Miss. Farm Res. 18 (5): 1, 2–5, 8, illus.

(13) GRISSOM, P. H., RANEY, W. A., and HOGG, P.
1955. CROP RESPONSE TO IRRIGATION IN THE YAZOO-MISSISSIPPI DELTA. Miss. Agr. Expt. Sta. Bul. 531, 24 pp.

(14) HUBER, L. L.
1955. PENNSYLVANIA CORN PERFORMANCE STUDIES: DOUBLE CROSS TESTS—1954. Pa. Agr. Expt. Sta. Prog. Rpt. 137, 12 pp., illus.

(15) JAMISON, V. C., and KROTH, E. M.
1958. AVAILABLE MOISTURE STORAGE CAPACITY OF SOILS IN RELATION TO SOIL TEXTURE AND ORGANIC MATTER CONTENT. Soil Sci. Soc. Amer. Proc. 22 (3): 189-192.

(16) KUMMER, F. A.
1955. SUMMARY OF RESEARCH ON IRRIGATION OF ROW CROPS IN ALABAMA. Ala. Agr. Expt. Sta. Water Resources and Sup. Irrig. Workshop Proc., pp. 18–19.

(17) LUND, C. M., LAW, W. P., and BEALE, O. W.
1955. SPRINKLER IRRIGATION OF FIELD CORN. S. C. Agr. Expt. Sta. Bul. 421, 34 pp., illus.

(18) MURPHY, B. C.
1954. IRRIGATION AND OTHER CULTURAL STUDIES WITH SWEET CORN. Miss. Agr. Expt. Sta. Inform. Sheet 494, 1 p.

(19) PECK, N. H.
1956. IRRIGATION MADE THE DIFFERENCE. N. Y. State Agr. Expt. Sta. Farm Res. 22 (2): 6, illus.

(20) PICTON, W. L.
1956. SUMMARY INFORMATION ON WATER USE IN THE UNITED STATES, 1900–1975. U. S. Dept. Com. Business Serv. Bul. 136, 6 pp., illus. [Processed.]

(21) QUACKENBUSH, T. H., RENFRO, G. M., BEAUCHAMP, K. H., and others.
1957. CONSERVATION IRRIGATION IN HUMID AREAS. U. S. Dept. Agr., Agr. Handb. 107, 52 pp., illus.

(22) RICHARDSON, J. B., and BEALE, O. W.
1947. IRRIGATION OF CORN. S. C. Agr. Expt. Sta. Ann. Rpt. 59: 24–29, illus.

(23) SCHWAB, G. O., SHRADER, W. D., NIXON, P. R., and SHAW, R. H.
1958. RESEARCH ON IRRIGATION OF CORN AND SOYBEANS AT CONESVILLE AND ANKENY, IOWA, 1951-1955. Iowa Agr. Expt. Sta. Res. Bul. 458, pp. 245–259, illus.

(24) SMITH, D. D.
1954. FERTILITY INCREASES EFFICIENCY OF SOIL MOISTURE. Better Crops With Plant Food 38 (6): 11–12, 39, illus.

(25) SNIDER, R. G.
1957. YOUR SHARE IN TOMORROW'S WATER. Agron. Jour. 49: 167–172.

(26) SOIL CONSERVATION SERVICE.
TENTATIVE SPRINKLER IRRIGATION GUIDE FOR [certain areas and certain States]. [Processed.]

(27) VAN BAVEL, C. H. M.
1956. ESTIMATING SOIL MOISTURE CONDITIONS AND TIME FOR IRRIGATION WITH THE EVAPOTRANSPIRATION METHOD. U. S. Dept. Agr. ARS–41–11, 16 pp., illus. [Processed.]

(28) ——— FORREST, L. A., and PEELE, T. C.
1957. AGRICULTURAL DROUGHT IN SOUTH CAROLINA. S. C. Agr. Expt. Sta. Bul. 447, 36 pp., illus.

(29) ——— and LILLARD, J. H.
1957. AGRICULTURAL DROUGHT IN VIRGINIA. Va. Agr. Expt. Sta. Tech. Bul. 128, 38 pp., illus.

(30) ——— and VERLINDEN, F. J.
1956. AGRICULTURAL DROUGHT IN NORTH CAROLINA. N. C. Agr. Expt. Sta. Tech. Bul. 122, 60 pp., illus.

(31) United States Weather Bureau, Hydrologic Services Division.
1955. RAINFALL INTENSITY-DURATION-FREQUENCY CURVES FOR SELECTED STATIONS IN THE UNITED STATES, ALASKA, HAWAIIAN ISLANDS AND PUERTO RICO. U. S. Dept. Com. Weather Bur. Tech. Paper 25, 53 pp., illus.

(32) WHITT, D. M.
1954. EFFECTS OF SUPPLEMENTAL WATER ON FIELD CROPS. Mo. Agr. Expt. Sta. Bul. 616, 8 pp., illus.

U. S. GOVERNMENT PRINTING OFFICE: 1958